植物研究雑誌
J. Jpn. Bot.
72: 273–285 (1997)

A Systematic Reevaluation of *Aconitum chiisanense* Nakai (Ranunculaceae), a Rare Endemic Species of Korea

Chong-Wook PARK and Sang-Hun OH

Department of Biology, College of Natural Sciences, Seoul National University, Seoul 151-742, KOREA

(Received on March 17, 1997)

To determine whether *Aconitum chiisanense* is distinct from *A. jaluense* subsp. *jaluense*, karyotypic and morphological features of the two taxa were examined. *Aconitum chiisanense* has the chromosome number of 2n=16, but *A. jaluense* subsp. *jaluense* has 2n=32; the latter taxon shares the same basic karyotype with the former taxon but at the tetraploid level. Morphological analyses also indicated that the two taxa are significantly different in a number of characters primarily related to the size and shape of leaves and pedicel hairs; *A. chiisanense* is distinguished from *A. jaluense* subsp. *jaluense* by its smaller, more deeply incised leaves with narrowly lanceolate laciniae and caudate apices and by its short, swollen-based pedicel hairs. These results strongly suggest that *A. chiisanense* is distinct from *A. jaluense* subsp. *jaluense* and should be recognized as a separate species.

Introduction

The genus *Aconitum* L. is composed of ca. 300 species (Kadota 1987), and usually defined within the Ranunculaceae by zygomorphic flowers and spurred, long-stipitate, nectariferous petals (Tamura 1966b). The species of *Aconitum* are found in cold temperate to temperate regions of the Northern Hemisphere including Asia, North America, and Europe, with the center of diversity in eastern Asia (Hardin 1964, Tamura 1966a). The genus has been divided into three subgenera; these include subgn. Aconitum with biennial tubers, subgn. Lycoctonum Tourn. with perennial rhizomes, and Gymnaconitum (Stapf) Rapaics with annual roots (Wang 1979, Kadota 1987).

Aconitum chiisanense Nakai belongs to the subgn. Aconitum, and is an endemic species of Korea. The species is very rare in distribution, and only a few isolated populations are found in shady, moist habitats with rich soils along the ridges of Mt. Chiri and Mt. Sorak in South Korea. The species was first described by Nakai (1935a) from Mt. Chiri in southern Korea mainly on the basis of its leaf shape. In the original description, Nakai (1935a) stated that *A. chiisanense* is very distinct from other species in the genus in having deeply three-parted leaves with bipinnately dissected lobes, elongated caudate leaf apices, and pubescent pedicels and ovaries. Since Nakai described *A. chiisanense*, it has been accepted as a distinct species by most Korean botanists (Chung 1957, Park 1974, Lee 1979).

Recently, however, Kadota (1987) pointed out that *A. chiisanense* is well within the range of variability of *A. jaluense* Kom. subsp. *jaluense*, and placed the former in synonymy under the latter. *Aconitum jaluense* subsp. *jaluense* is distributed from northeastern China through Korea to southern Japan, and shows

considerable variation in leaf lobe dissection and lacinia shape; Kadota (1987) considered *A. chiisanense* as a form of *A. jaluense* subsp. *jaluense* having leaves with deeply incised lobes and narrow lanceolate or subulate laciniae.

The objective of this study is to determine whether *A. chiisanense* is distinct from *A. jaluense* subsp. *jaluense* on the basis of cytological observation and detailed morphological analyses.

Materials and Methods

Cytology: Individuals transplanted from the field to the greenhouse and the experimental garden at Seoul National University were examined for mitotic chromosome number and karyotype (Table 1). Root tips were pretreated in a solution of 0.1% colchicine (w/v) for 3 hours at 4°C, fixed in acetic alcohol (glacial acetic acid:ethanol, 1:3, v/v) for 30 minutes, and softened 6 minutes in a 1:1 mixture of 1 N HCl and 45% acetic acid at 60°C. Root tips were then stained and squashed in 1% acetic orcein using the procedure of Darlington and LaCour (1976).

Chromosome preparations were observed and photographed with an Olympus CH-2 microscope at 2000×. Chromosome measurements were made from photographs of well-spread chromosome preparations, and the centromeric index (Levan et al. 1964) for each chromosome was calculated. Karyotypes were constructed by arranging the chromosomes in

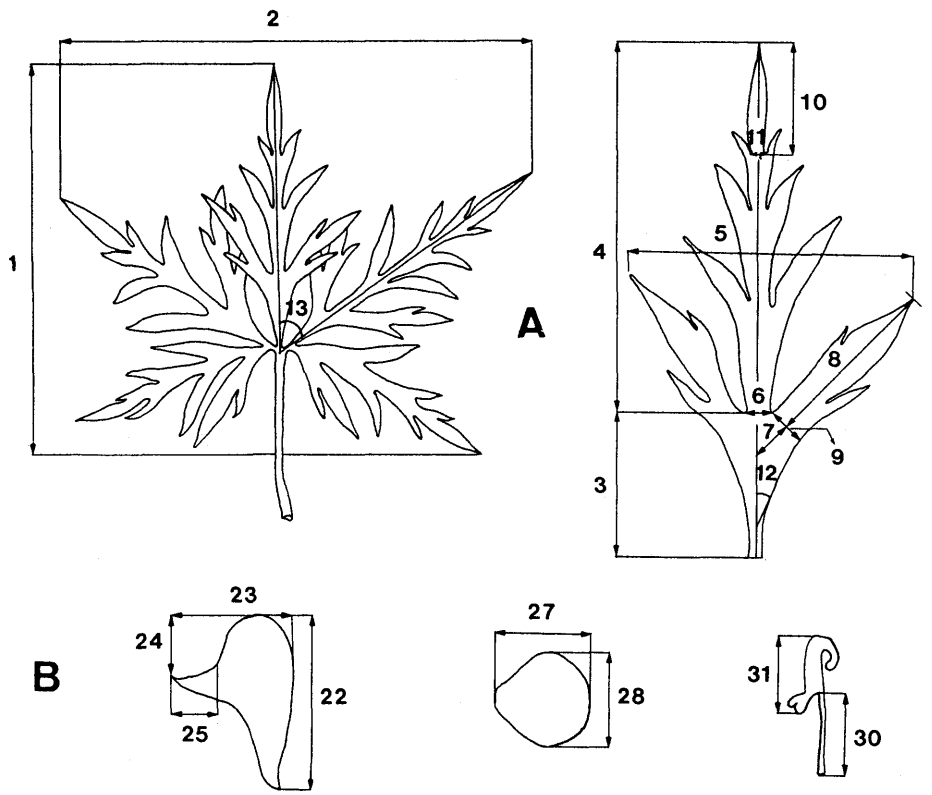

Fig. 1. Diagram showing leaf (A) and floral characters (B) measured for numerical analyses of *Aconitum chiisanense* and *A. jaluense* subsp. *jaluense*. Numbers correspond to character numbers in Table 2.

order of decreasing size, and the system of Levan et al. (1964) was adopted for classification of chromosomes.

Morphological analyses: Data used in this study were obtained from the individuals collected by the authors in Korea from 1993 to 1995 and the specimens deposited in SNU. Field observations of *A. chiisanense* and *A. jaluense* subsp. *jaluense* were also made in August and/or September of 1993, 1994, and 1995. Specimens were identified by the characters mentioned in the original descriptions and those used by previous authors (Komarov 1901, Nakai 1935a, 1935b, 1953, Chung 1957, Park 1974, Lee 1979, Park et al. 1997).

After removal of duplicates and poor specimens, 66 individuals having both well-developed leaves and inflorescences were selected for numerical analyses of morphological variation; these include 26 of *A. chiisanense* and 40 of *A. jaluense* subsp. *jaluense*. All vouchers are at SNU, and a list of specimens used for this study is available from the first author upon request.

From these individuals, 32 vegetative and floral characters, 10 of which were derived ratios, were measured for morphological analyses (Table 2, Fig. 1). Leaf characters were measured on the largest, fully mature leaf, and floral ones were taken from mature flowers on a well-developed inflorescence. Length of pedicel hairs was measured using an ocular micrometer under a stereoscopic microscope.

To better evaluate the distinctness of these two taxa, a data set derived from the above measurements was subjected to principal components analysis and cluster analysis. The principal components analysis and cluster analysis were conducted using Statistical Analysis System (SAS Institute 1990; Release 6.04) and NTSYS (Rohlf 1988; ver. 1.50), respectively, on an IBM PC. Data matrix used for the analyses is available from the first author upon request.

Pedicel hairs of these two taxa were examined with a scanning electron microscope (SEM). Pedicels fixed in FAA were dehydrated in a graded series of acetone concentrations, followed by critical-point-drying in a Polaron Model E3000 critical-point-drying apparatus with liquid carbon dioxide. Dried samples mounted on aluminum stubs were coated with gold, and examined and photographed using an Akashi Model SR-50A SEM.

Table 1. Chromosome numbers and collection data for *Aconitum chiisanense* and *A. jaluense* subsp. *jaluense*. All vouchers are at SNU

A. chiisanense Nakai, 2n=16. KOREA. Kangwon Prov.: Mt. Sorak, alt. 900 m, Oh 200. Kyungnam Prov. Mt. Chiri: Samshinbong, alt. 1,500 m, Oh R106; Changteomok, alt. 1,630 m, Oh T105.

A. jaluense Kom. subsp. *jaluense*, 2n=32. KOREA. Kangwon Prov.: Mt. Sorak, near Paekdam Temple, alt. 500 m, Oh 202. Kyunggi Prov.: Mt. Myungji, alt. 700 m, Oh 2760, 2761; Mt. Kukmang, alt. 1,000 m, Oh 201.

Results and Discussion

Cytology: Chromosome numbers and collection data for *A. chiisanense* and *A. jaluense* subsp. *jaluense* are provided in Table 1. Photographs and karyograms of mitotic chromosomes of these two taxa are shown in Fig. 2.

Root tip chromosomal preparations showed that the chromosome number of *A. jaluense* subsp. *jaluense* is 2n=32 (Table 1, Fig. 2B), which is in agreement with the previous report (Kadota 1987). *Aconitum chiisanense*, however, appeared to have the chromosome number of 2n=16 (Table 1, Fig. 2A); our count of 2n=16 for *A. chiisanense* is the first report for this taxon. The average length of mitotic chromosomes ranges from 1.48 ± 0.26 to 7.36 ± 0.95 μm in *A. jaluense* subsp. *jaluense*, and from 1.68 ± 0.27 to 7.88 ± 0.65 μm in *A. chiisanense* (Fig. 2).

Table 2. Morphological characters used in numerical analyses of *Aconitum chiisanense* and *A. jaluense* subsp. *jaluense*. See Fig. 1 for further clarification

Vegetative characters:

1. Leaf length [cm]
2. Leaf width [cm]
3. Distance between the middle lobe base and the primary incision point of the middle lobe [cm]
4. Distance between the middle lobe apex and the primary incision point of the middle lobe [cm]
5. Maximum middle lobe width [cm]
6. Middle lobe width at the primary incision point [cm]
7. Distance between the primary lacinia base and the midvein of the middle lobe [cm]
8. Length of primary lacinia of the middle lobe [cm]
9. Width of primary lacinia of the middle lobe [cm]
10. Middle lobe apex length [cm]
11. Middle lobe apex width at the base [cm]
12. Middle lobe basal angle [half angle; degree]
13. Angle between the middle lobe and the lateral lobe [degree]
14. Character 1/character 2
15. Character 4/(character 3 + character 4)
16. Character 6/character 5
17. Character 5/(character 3 + character 4)
18. (Character 3 + character 4)/petiole length
19. Character 10/character 11
20. Character 8/(character 7 + character 8)
21. Pedicel hair length [mm]

Floral characters:

22. Helmet (upper sepal) length [cm]
23. Helmet width [cm]
24. Distance between the beak and the helmet apex [cm]
25. Beak length [cm]
26. Character 23/character 24
27. Lateral sepal length [cm]
28. Lateral sepal width at the widest point [cm]
29. Character 27/character 28
30. Petal stipe length [cm]
31. Petal labium length [cm]
32. Character 31/character 30

Aconitum chiisanense (2n=16) has an asymmetric karyotype consisting of two long and six short pairs of chromosomes (Fig. 2C). The two long chromosome pairs differ in centromere position; chromosome pairs 1 and 2 have median and submedian centromeres, respectively. In addition, pair 2 is slightly shorter than pair 1. The six short chromosome pairs have submedian centromeres and are very similar in morphology, but pair 8 is recognizable by its much smaller size. *Aconitum jaluense* subsp. *jaluense*, which differs from

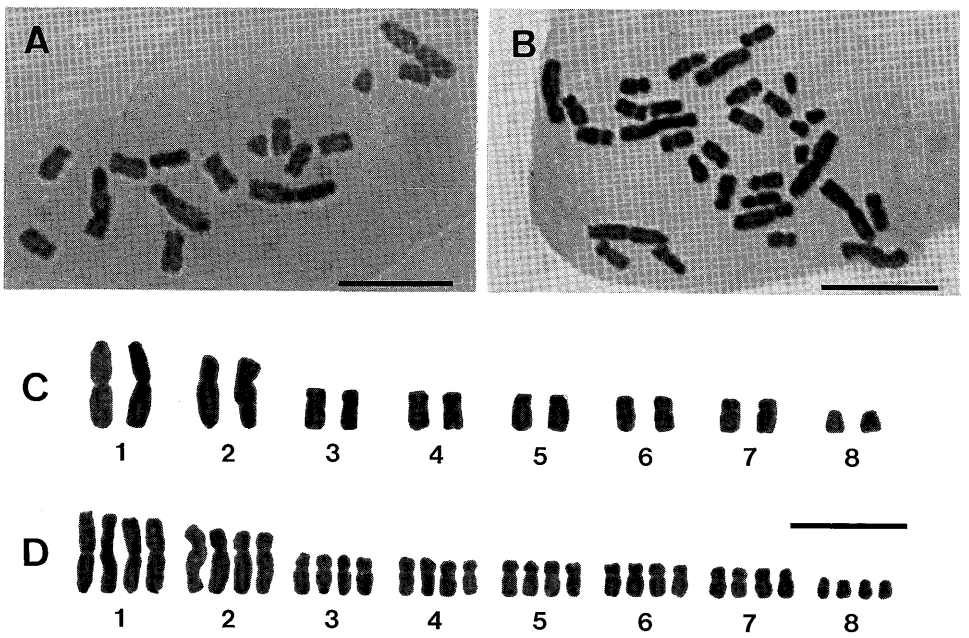

Fig. 2. Mitotic chromosomes and karyograms of *Aconitum chiisanense* (A, C) and *A. jaluense* subsp. *jaluense* (B, D). Scale bars = 10 μm.

A. chiisanense in chromosome number (2n=32), shares this same basic karyotype but at the tetraploid level (Fig. 2D).

Morphological analyses: Kadota (1987) indicated that *A. chiisanense* is well within the range of variability of *A. jaluense* subsp. *jaluense* in gross morphology, but our measurements showed that the former differed from the latter in a number of characters (Figs. 3, 4). T-test (Snedecor and Cochran 1980) displayed statistically significant differences at $p<0.001$ between the two taxa for 22 (1–9, 11–13, 15–21, 24, 26, 30; parenthetical numbers here and subsequently refer to character numbers in Table 2) of 32 characters measured. In particular, *A. chiisanense* is strongly different from *A. jaluense* subsp. *jaluense* in characters related to lacinia width (6, 7, 9, 11) and apex shape (19); it has significantly narrower laciniae and lacinia apices as compared to *A. jaluense* subsp. *jaluense*. In addition, it tends to have smaller leaves (1, 2) and more deeply incised middle lobes (6, 20) (Fig. 3).

Besides the leaf characters, the two taxa showed a noticeable difference in length (21) and shape of pedicel hairs. Characteristics of pedicel pubescence have been considered to be very useful for species delimitation and for recognizing species relationships in *Aconitum* (Nakai 1909, 1914, 1920, 1935a, 1935b, 1937, 1950, 1953, Tamura and Namba 1959, 1960, Hardin 1964, Park 1974, Wang 1979, Kadota 1981, 1987, Park et al. 1997). Pedicels of both taxa are moderately to densely pubescent with smooth-surfaced simple unicellular spreading glandular hairs (Fig. 5). In *A. chiisanense*, pedicel hairs are very short (0.26–0.45 mm in length) and more or less swollen at the base, but in *A. jaluense* subsp. *jaluense* they are much longer (0.59–1.04 mm in length) and filiform in shape (Figs. 3, 5).

Among 11 floral characters measured, helmet (upper sepal) width (23), distance between the beak and the helmet apex (24), beak

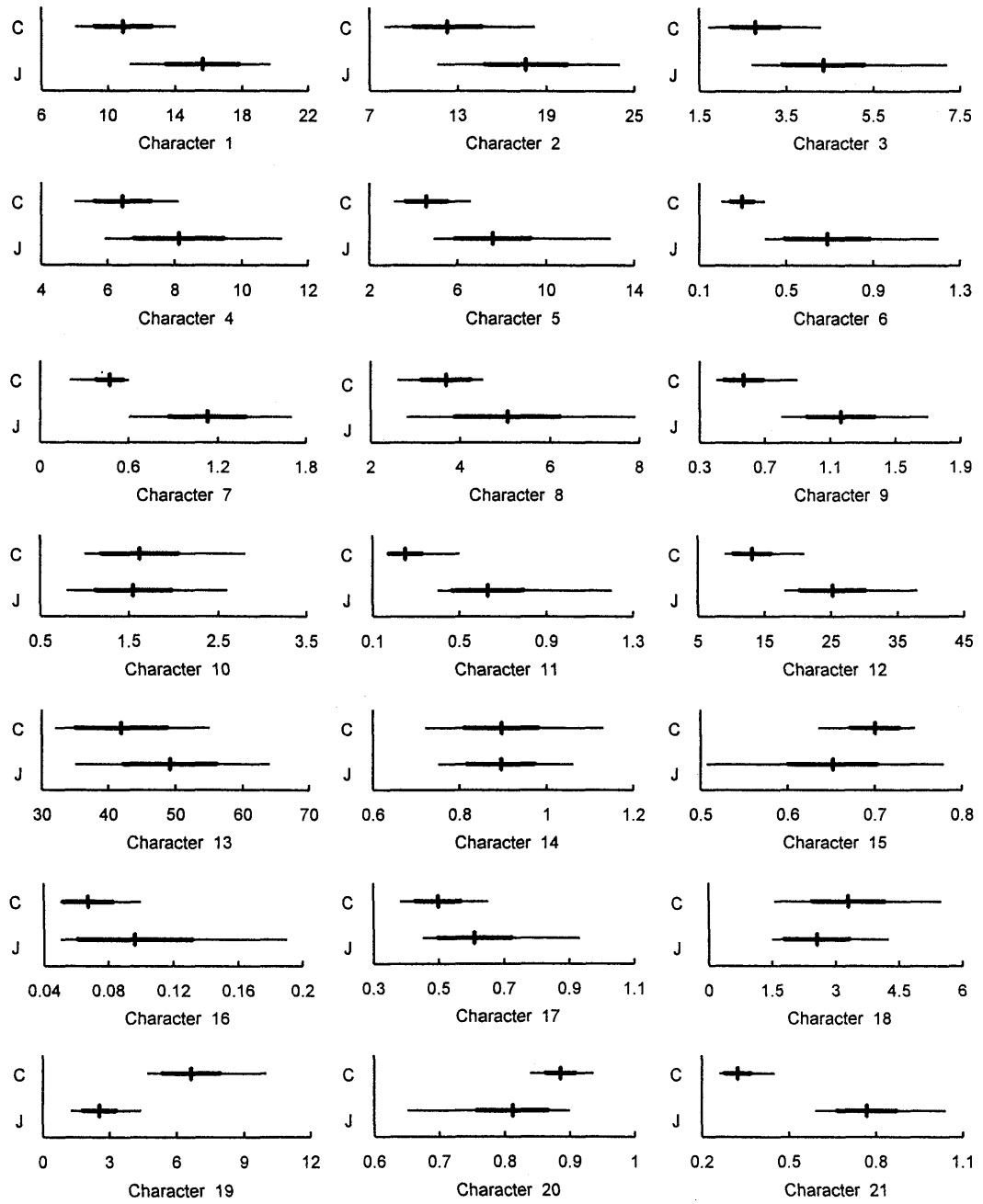

Fig. 3. Ranges, means, and standard deviations for 21 vegetative characters measured from individuals of *Aconitum chiisanense* (C) and *A. jaluense* subsp. *jaluense* (J). Means are indicated by vertical lines, and standard deviations, by thickened horizontal lines. Character numbers correspond to those in Table 2 and Fig. 1.

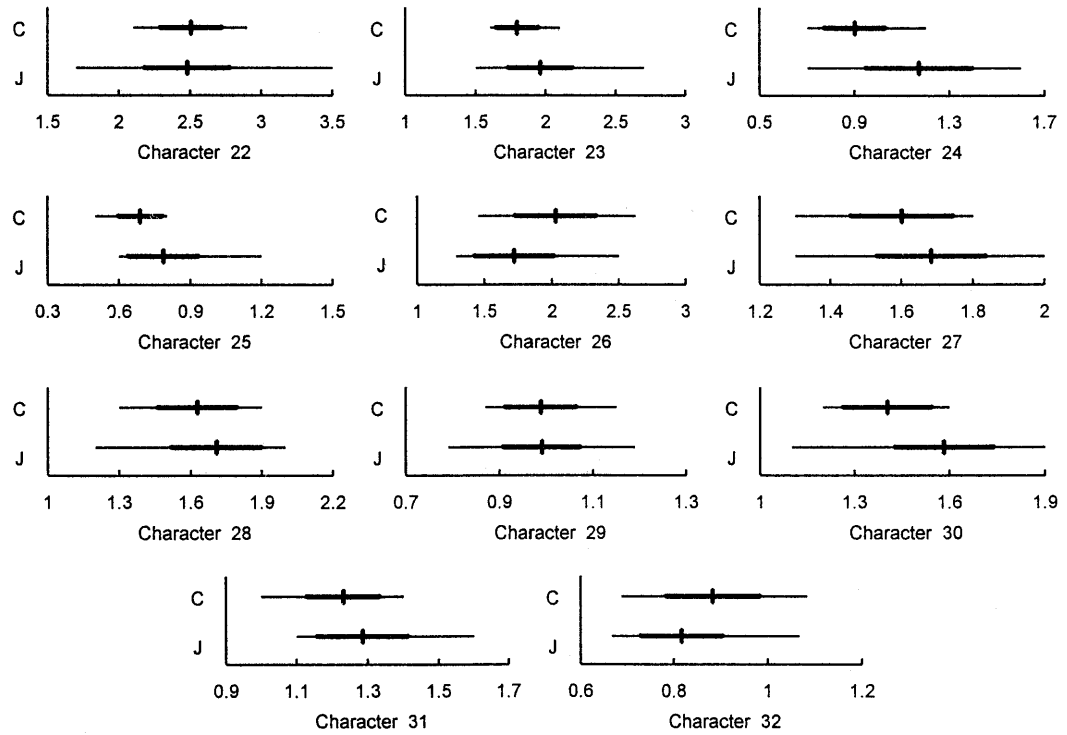

Fig. 4. Ranges, means, and standard deviations for 11 floral characters measured from individuals of *Aconitum chiisanense* (C) and *A. jaluense* subsp. *jaluense* (J). See Fig. 3 for further explanations.

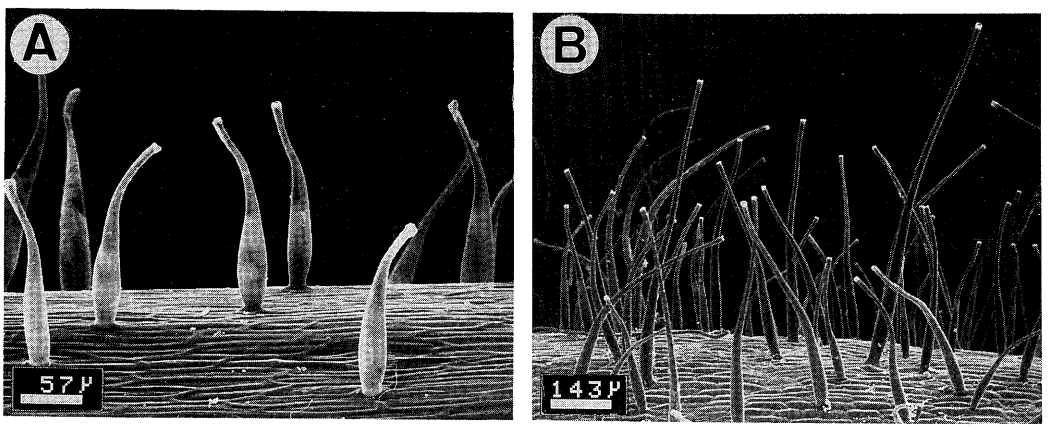

Fig. 5. Pedicel pubescence of *Aconitum chiisanense* (A) and *A. jaluense* subsp. *jaluense* (B).

length (25), ratio of helmet width/distance between the beak and the helmet apex (26), lateral sepal length (27), petal stipe length (30), and ratio of petal labium length/petal stipe length (32) showed statistically significant differences at $p<0.05$–0.001 between the two taxa. However, *A. jaluense* subsp. *jaluense* displayed considerable variation in these

characters, the ranges of which for the two taxa were almost completely overlapped (Fig. 4).

Principal components analysis was conducted to examine the degree of distinctness of *A. chiisanense* and *A. jaluense* subsp. *jaluense* with regard to the variation in 32 morphological characters measured (Table 2). The first three principal components accounted for 37.4, 14.0, and 10.1 percent of the total variance, respectively (Table 3), and subsequent components contributed less than 6 percent each. The first principal component has relatively high positive loadings for leaf length (1), leaf width (2), distance between the middle lobe base and the primary incision point of the middle lobe (3), maximum middle lobe width (5), middle lobe width at the primary incision point (6), distance between the primary lacinia base and the midvein of the middle lobe (7), width of the primary lacinia of the middle lobe (9), middle lobe apex width at the base (11), and pedicel hair length (21), and a high negative loading for ratio of middle lobe apex length/width (19). The second principal component was weighted heavily for helmet length (22) and lateral sepal width at the widest point (28); it also has relatively high loadings for helmet width (23), beak length (25), lateral sepal length (27), petal stipe length (30), and petal labium length (31). The third principal component was related to ratio of middle lobe width at the primary incision point/maximum middle lobe width (16) and ratio of primary lacinia length/distance between the primary lacinia apex and the midvein of the middle lobe (20) (Table 3).

The projection of the individuals onto the first two principal components revealed that individuals of *A. chiisanense* and *A. jaluense* subsp. *jaluense* are separable on the basis of the morphological characters included in the analysis (Fig. 6). In the plot (Fig. 6), individuals of *A. chiisanense* are completely separated from those of *A. jaluense* subsp. *jaluense* mainly by the first principal component, which is primarily a function of characters related to leaf size, lacinia width, degree of leaf incision, apex shape, and pedicel hair length (Table 3). The relative positions of individuals of these two taxa on the first principal component (Fig. 6) suggest that the plants of *A. chiisanense* tend to have smaller leaves with more deeply incised middle lobes, narrower laciniae with caudate apices, and much shorter pedicel hairs as compared to those of *A. jaluense* subsp. *jaluense*. However, the second principal component, which is primarily a function of characters related to floral features, failed to separate the two taxa, suggesting that the floral characters are not useful for distinguishing the two taxa.

The UPGMA-derived phenogram based on average taxonomic distance computed from the same standardized data set also showed a good separation of individuals of *A. chiisanense* from those of *A. jaluense* subsp. *jaluense* (Fig. 7). In summary, both univariate statistical tests and multivariate phenetic analyses of 32 characters measured strongly support the contention (Nakai 1935a, 1935b, 1953, Chung 1957, Park 1974, Lee 1979) that *A. chiisanense* is morphologically distinct from *A. jaluense* subsp. *jaluense*.

Conclusion

The results presented here indicated that the merger of *A. chiisanense* with *A. jaluense* subsp. *jaluense* by Kadota (1987) is not warranted. Cytological observation revealed that the former is diploid (2n=16), whereas the latter is tetraploid (2n=32). In addition, morphological analyses clearly demonstrated that the two taxa differ in size and shape of leaves and pedicel hairs. Diagnostically, *A. chiisanense* is distinguishable from *A. jaluense* subsp. *jaluense* by its smaller, more deeply incised leaves with narrowly lanceolate laciniae and caudate apices and by its short, swollen-

Table 3. Loadings of the first three principal components for 32 morphological characters from the analysis of 66 individuals of *Aconitum chiisanense* and *A. jaluense* subsp. *jaluense*. Character numbers correspond to those in Table 2

Character no.	Component		
	1	2	3
1	0.2464	–0.1330	0.1452
2	0.2310	–0.1651	0.1736
3	0.2356	–0.0646	–0.0102
4	0.1852	–0.1755	0.2577
5	0.2201	–0.2029	0.1971
6	0.2443	0.0246	–0.2251
7	0.2532	–0.0524	–0.1870
8	0.1773	–0.2177	0.2957
9	0.2614	–0.0743	–0.0541
10	0.0046	–0.2048	0.1690
11	0.2371	–0.1064	–0.0608
12	0.2099	–0.0181	–0.0995
13	0.1311	–0.0863	–0.0194
14	–0.0081	0.0933	–0.1196
15	–0.1725	–0.0491	0.2094
16	0.1348	0.1755	–0.3873
17	0.1379	–0.1669	0.1412
18	–0.1207	0.0043	–0.0173
19	–0.2412	0.0173	0.1184
20	–0.1846	–0.0803	0.3803
21	0.2571	0.0060	–0.0990
22	0.0303	0.3784	0.1792
23	0.1447	0.2591	0.2727
24	0.1910	0.1536	0.0785
25	0.1369	0.2793	0.0580
26	–0.1407	–0.0264	0.0884
27	0.1146	0.2662	0.1753
28	0.0867	0.3457	0.2014
29	0.0136	–0.1769	–0.0779
30	0.1729	0.2648	0.1199
31	0.0791	0.2823	0.0976
32	–0.1138	–0.0305	–0.0541
Eigenvalue	11.9745	4.4664	3.2317
Cumulative % of eigenvalues	37.4	51.4	61.5

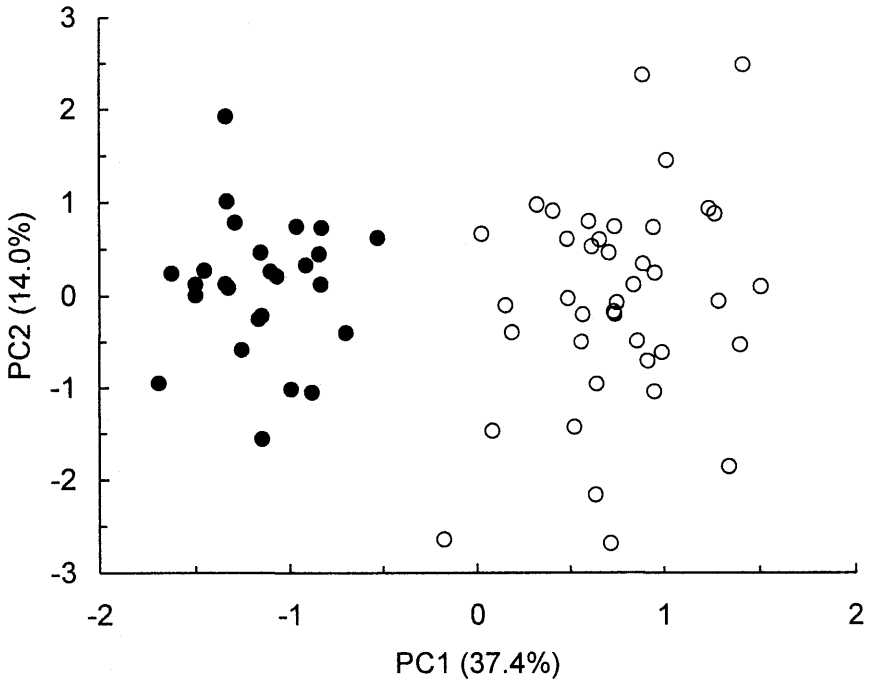

Fig. 6. Principal components analysis of *Aconitum chiisanense* and *A. jaluense* subsp. *jaluense* using 32 morphological characters (cf. Table 2). Some individuals are hidden due to the same values. Symbols: Closed circles = *A. chiisanense*, open circles = *A. jaluense* subsp. *jaluense*.

based pedicel hairs. Preliminary result of the artificial crossing trials of these two taxa also showed that they are genetically isolated from each other completely (Park and Oh unpubl. data). These observations strongly indicated that *A. chiisanense* is distinct from *A. jaluense* subsp. *jaluense*, and support the recognition of the former as a distinct species.

Aconitum chiisanense Nakai, J. Jpn. Bot. **11**: 147 (1935). Type: Korea. Chunnam Prov., Mt. Chiri, Oct. 4, 1934, M. K. Park 5 (holotype TI [not seen]; isotype, SNU!) [Fig. 8].

Erect to slightly reclining perennial herb arising from biennial tuberous root system, 40–80 cm tall; tubers thick, dark brown, fusiform, 1.3–2.5 cm long, 6–9 mm in diameter; daughter tubers usually 1–3, obovoidal. Stem pale green, unbranched, terete, 2–4 mm in diameter at the lower node, glabrous. Leaves alternate, membraneous, long-petioled, basal ones usually withering in flowering time; blades roundish pentagonal to pentagonal in outline, 8.0–14.0 cm long, 8.0–18.2 cm wide, deeply 3-lobed nearly to the base, bearing a few antrorsely curved cilia at the margin; upper surfaces green, sparsely pubescent with simple unicellular micropapillate curved glandular hairs 1–2 mm long; lower surfaces light green, almost glabrous, bearing a few curved glandular hairs identical to those of upper surfaces along major veins; middle lobe rhomboid in outline, 6.7–11.8 cm long, 3.1–6.6 cm wide, deeply and pinnately to bipinnately incised with narrow linear lanceolate to subulate laciniae, middle lobe and lacinia apices long-acuminate to caudate, middle lobe base attenuate; primary laciniae of the middle lobe 2.6–4.5 cm long, 4–9 mm wide; lateral lobes deeply incised with 2 unequal segments; inner segment rhomboid in outline, 6.4–11.7 cm long,

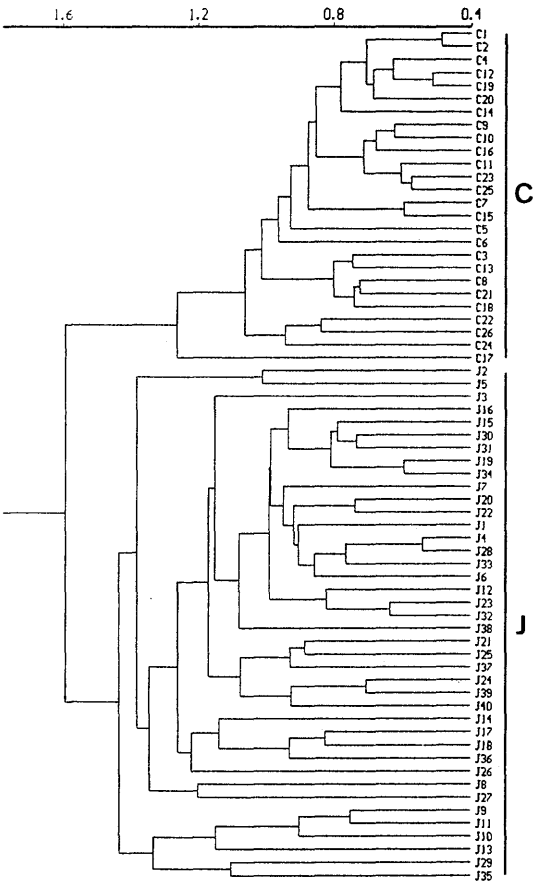

Fig. 7. UPGMA phenogram for 66 OTUs of *Aconitum chiisanense* (C) and *A. jaluense* subsp. *jaluense* (J) based on average taxonomic distance computed from 32 standardized characters (cf. Table 2).

3.1–5.5 cm wide, deeply and pinnately to bipinnately incised with linear lanceolate to subulate laciniae as in middle lobe; outer segment more or less rhomboid in outline but asymmetrical, smaller, 5.0–7.5 cm long, 2.3–5.1 cm wide, deeply subdivided into 2 unequal parts, each part deeply incised with linear lanceolate to lanceolate laciniae; petioles 1.8–4.7 cm long, glabrous, grooved adaxially. Inflorescences terminal or in the axils of upper leaves, definite, usually loose corymbriform with 2–4 flowers, sometimes paniculiform in well-developed individuals, often solitary in small individuals; pedicels ascending, relatively long, 2.3–5.5 cm long, ca. 1 mm in diameter, moderately to densely pubescent with simple spreading glandular hairs; glandular hairs unicellular, straight, short, 0.26–0.45 mm long, smooth-surfaced, somewhat swollen at the base; bracteoles 2, born near the base of pedicels, lanceolate, 1.6–5.1 mm long, 0.5–1.3 mm wide, acute at the apex, moderately pubescent with simple spreading glandular hairs identical to those of pedicels. Flowers bisexual, zygomorphic, 3.8–4.5 cm long, 1.5–2.0 cm wide; sepals 5, petaloid, bluish purple, outer surfaces sparsely pubescent with simple spreading glandular hairs identical to those of pedicels, inner surfaces sparsely to moderately pubescent with long filiform micropapillate spreading hairs ca. 0.8–1.6 mm long together with varying densities of simple spreading glandular hairs identical to those of pedicels; upper sepal (helmet) 1, hooded, 2.1–2.9 cm long, 1.6–2.1 cm wide, round at the apex, with projecting beaks 5–8 mm long; lateral sepals 2, roundish, 1.3–1.8 cm long, 1.3–1.9 cm wide; lower sepals 2, unequal in shape, one usually elliptic, 1.2–1.4 cm long, 4–7 mm wide, the other one oblanceolate, 1.2–1.6 cm long, 2–3 mm wide, both acute at the apex; petals 2, highly modified, hammer-shaped, glabrous, nectariferous, enclosed in upper sepal, each composed of a spurred limb and a long stipe; labium bluish purple, dilated, 1.0–1.4 cm long, tip obovate and emarginate; spur relatively long, curved inward; stipe elongate, 1.2–1.6 cm long. Stamens 40–50, spirally arranged, glabrous; filaments filiform, dilated and winged below middle portion, tip of the wing acuminate; anthers bilocular, broadly elliptic, longitudinally dehiscent. Pistils 3, rarely 4; ovaries unilocular, narrowly ovoidal, 6–9 mm long when mature, densely pubescent with simple spreading glandular hairs identical to those of pedicels; glandular

Fig. 8. *Aconitum chiisanense* (Changteomok, Mt. Chiri, Korea, Sept. 7, 1994).

hairs 0.2–0.4 mm long; styles elongate, 1.5–3.2 mm long, glabrous. Follicles oblong in outline, 1.2–1.5 cm long, 4–5 mm wide, somewhat divergent, moderately pubescent with simple spreading glandular hairs, each containing 9–15 seeds. Seeds blackish brown, triquatrous, 2–5 mm long, 1–3 mm wide, bearing bandlike scale along one longitudinal edge, transversely squamate with somewhat rugous scales on opposite side; scales thin, membraneous, dark brown, micropapillate.

Specimens examined: Korea. Chunnam Prov. Mt. Chiri: Shimwon-Nogodan-Hwaeom Temple, Jul. 23, 1963, Lee et al. s.n. (SNUA); Banyabong, in 1934, Park s.n. (SNU). Kangwon Prov.: Mt. Sorak, Twelve Nymphs Valley, Oct. 5, 1993, Lee 12 (SNU). Kyungnam Prov. Mt. Chiri: Saesuk, Aug. 3, 1960, Lee 97 (SNUA [2 sheets]); Saesuk-Chunwhangbong, Aug. 1, 1963, Lee et al. s.n. (SNUA [2 sheets]); near Beopchun Waterfall, alt. 1300 m, Oct. 17, 1996, Lim et al. 3001–3007 (SNU); Changteomok, N-facing slope near camp site, under *Abies-Acer* forest, alt. 1630 m, Oct. 17, 1996, Lim et al. 3008–3011 (SNU); Yunhwabong, along the ridge, alt. 1640 m, Oct. 18, 1996, Lim et al. 3012–3015 (SNU); along the ridge ca. 700 m E from Chotdaebong, under *Acer-Abies-Rhododendron* forest, alt. 1640 m, Oct. 18, 1996, Lim et al. 3016–3024 (SNU); in valley en route from Saesuk to Kourim, under Acer-Abies forest, alt. 1000 m, Oct. 18, 1996, Lim et al. 3025–3028 (SNU); Changteomok, near camp site, Aug. 3, 1994, Oh & Kang 211, 212 (SNU); along the ridge ca. 700 m E from Chotdaebong, under *Acer-Abies-Rhododendron* forest, alt. 1640 m, Sep. 7, 1994, Oh & Kang 2352–2358 (SNU); Samshinbong, along the ridge under Rhododendron community, alt. 1500 m, Sep. 7, 1994, Oh & Kang 2359–2361 (SNU); Changteomok, N-facing slope near camp site, under *Abies-Acer* forest, alt. 1630 m, Sep. 7, 1994, Oh & Kang 2363–2366, 2368–2372, 2374–2376, 2378 (SNU); Changteomok, N-facing slope near camp site, under *Abies-Acer* forest, alt. 1630 m, Nov. 7, 1994, Oh & Kang 2673, 2674, 2679 (SNU); Chungsanri Valley, alt. 1400 m, Sep. 21, 1995, Oh & Kang 2738, 2740, 2741, 2743, 2745–2747 (SNU); Changteomok, N-facing slope near camp site, under *Abies-Acer* forest, alt. 1630 m, Sep. 21, 1995, Oh & Kang 2749–2752 (SNU); Chotdaebong, Jul. 1994, Won 101, 102 (SNU). CULTIVATED PLANTS. Korea. Seoul. Experimental garden at Seoul National University: Transplanted from Mt. Sorak, alt. 900 m, Sep. 25, 1995, Oh 200 (SNU); transplanted from Samshinbong, Mt. Chiri, alt. 1500 m, Sep. 25, 1995, Oh R106 (SNU); transplanted from Changteomok, Mt. Chiri, alt. 1630 m, Sep. 25, 1995, Oh T105 (SNU); transplanted from Changteomok, Mt. Chiri, Oct. 25, 1995, Oh & Kang E3001, E3003 (SNU).

This research was supported by a grant from KOSEF (grant no. 941-0500-019-2) to C.-W. Park. We thank Sun Kang, Chae Eun Lim, Hyun-Woo Lee, and Hyosig Won for their assistance and help throughout the project.

References

Chung T. H. 1957. Korean Flora. Vol. 2 (Herbaceous Plants). Sinjisa, Seoul.

Darlington C. D. and LaCour L. F. 1976. The Handling of Chromosomes. 6th ed. George Allen and Unwin, London.

Hardin J. W. 1964. Variation in *Aconitum* of eastern United States. Brittonia **16**: 80–94.

Kadota Y. 1981. A taxonomic study of *Aconitum* (Ranunculaceae) of the Akaishi mountain range in central Japan. Bull. Natl. Sci. Mus., Tokyo, Ser. B. **7**: 91–112.

——— 1987. A Revision of *Aconitum* Subgenus *Aconitum* (Ranunculaceae) of East Asia. Sanwa Shoyaku Co. Ltd., Utsunomiya.

Komarov V. L. 1901. Species novae florae Asiae orientalis (Manshuriae et Koreae borealis). Trudy Imp. S.-Peterburgsk. Bot. Sada **18**: 417–449.

Lee T. B. 1979. Illustrated Flora of Korea. Hyangmunsa, Seoul.

Levan A., Fredga K. and Sandberg A. A. 1964. Nomenclature for centromeric position on chromosomes. Hereditas **52**: 201–220.

Nakai T. 1909. Flora Koreana. Pars prima. J. Coll. Sci. Imp. Univ. Tokyo **26**: 1–304.

——— 1914. Notulae ad plantas Japoniae et Koreae X. Bot. Mag. Tokyo **28**: 57–64.

——— 1920. Notulae ad plantas Japoniae et Koreae XXII. Bot. Mag. Tokyo **34**: 35–54.

——— 1935a. Some noticeable Japanese plants (I). J. Jpn. Bot. **11**: 147–156.

——— 1935b. Species jeholenses generis *Aconiti*, cum adnotationibus de speciebus affinitatis, nec non descriptionibus specierum et varietatum novarum in China boreali, Manshuria, et Korea detectarum. Rep. 1st Sci. Exp. Manch. Sect. IV, Part II: 127–163.

——— 1937. Notulae ad plantas Asiae orientalis (I). J. Jpn. Bot. **13:** 393–406.

——— 1950. A new classification of *Aconitum*-group of Manchuria, Korea, Japan, Formosa, Saghaline and the Kuriles. Bot. Mag. Tokyo **63**: 53–57.

——— 1953. A new classification of *Lycoctonum* and *Aconitum* in Korea, Japan, and their surrounding areas. Bull. Natn. Sci. Mus., Tokyo **32**: 1–53.

Park C.-W., Oh S., Lim C. E. and Suh Y. 1997. Morphological evidence of hybridization between *Aconitum japonicum* subsp. *napiforme* and *A. jaluense* subsp. *jaluense* (Ranunculaceae). J. Jpn. Bot. **72**: 144–153.

Park M. K. 1974. Keys to the Herbaceous Plants in Korea (Dicotyledoneae). Chungumsa, Seoul.

Rohlf F. J. 1988. NTSYS (Numerical Taxonomy and Multivariate Analysis System). Version 1.50. State University of New York, Stony Brook.

Snedecor G. W. and Cochran W. G. 1980. Statistical Methods. 7th ed. The Iowa State Univ. Press, Ames.

Tamura M. 1966a. Morphology, ecology and phylogeny of the Ranunculaceae V. Sci. Rep. Osaka Univ. **14**: 27–48.

——— 1966b. Morphology, ecology and phylogeny of the Ranunculaceae VI. Sci. Rep. Osaka Univ. **15**: 13–35.

——— and Namba T. 1959. *Aconitum* of Hokkaido and the Kuriles (*Aconitum* of Japan and the surrounding regions 2). Sci. Rep. Osaka Univ. **8**: 75-109.

——— and ——— 1960. *Aconitum* of Honshu, Shikoku and Kyushu (*Aconitum* of Japan and the surrounding regions 3). Sci. Rep. Osaka Univ. **9**: 106–146.

Wang W. T. 1979. *Aconitum.* Flora Reipublicae Popularis Sinicae **27**: 113–326. Science Press, Beijing.

朴　鍾郁，呉　相勲：**韓半島固有のトリカブト属希産種*Aconitum chiisanense* Nakai（キンポウゲ科）の分類学的再検討**

韓国・智異山に固有のチイサントリカブト *Aconitum chiisanense* Nakaiを，コウライブシ*A. jaluense* Kom. subsp. *jaluense*と比較しつつ，形態的形質や染色体数について調べた．その結果，2n＝32である4倍体種のコウライブシとは異なり，チイサントリカブトは2n＝16の2倍体種の一つであることが初めて明らかにされた．形態的にも，茎葉の裂片がより深く切れ込み，終裂片もより細く先端が尾状に長く尖ること，花梗にはえる開出毛の基部が肥大することなどでチイサントリカブトはコウライブシから区別できる．チイサントリカブトは花梗に開出毛が生え，茎葉の葉身が3全裂することなど共通の形態的形質をもつために，コウライブシと同一種とされたこともあったが明瞭に区別できる独立種であることが確認された．本論文では智異山の数多くの標本にもとづいてチイサントリカブトの詳細な再記載を行った．

（ソウル大学校自然科学大学生物学科）